

Published as: Good, P.R., Derudder, B. & Witlox, F.J. (2011), The regionalization of Africa: Delineating Africa's subregions using airline data. *Journal of Geography*, vol. 110 (5), p. 179-190.

The Regionalization of Africa:
Delineating Africa's Sub-regions Using Airline Data

Short Title: The Regionalization of Africa

Abstract:

Current regionalizations of Africa have limitations in that they are attribute-based and regions are delineated according to national boundaries. Taking the world city network approach as starting point, it is possible to use relational data (i.e. information about the relationships between cities) rather than attribute data, and moreover, it becomes possible to ignore state boundaries by delineating the regions based on the location of the interaction structure between cities. This research uses airline data. A network analysis is performed on data about the number of passengers who fly between cities in Africa. A sub-regional map is created based on the results. These results are compared with conventional regions found in undergraduate geography of Africa textbooks and with regional economic communities. Important similarities and differences to current regionalizations of Africa were found.

Keywords: urban, regional geography, geographic content knowledge, world city network, regional economic communities

1. INTRODUCTION

The study of the process of regionalization in the discipline of geography has seen several progressions during the past century. Africa has not been left out of this process. However, Africa is unique because it is fraught with issues such as Eurocentric approaches, a history of colonialism and imposed state boundaries that do not reflect the historical, or even the present, cultural patterns. A new method of regionalizing Africa, one that ignores state boundaries and is based on real connections, is proposed here. Using airline connections between 255 cities, a hierarchical urban network will be created and analyzed with the purpose of creating a

regionalization of Africa based on interaction spaces: the end-result will be a new regional map of Africa based on the structure of transnational urban networks.

The short-comings of current regionalization methods for Africa stem mainly from an attribute-based approach. In most textbooks, Africa has been divided up according to features such as native language group or climate. Sometimes physical and human features are combined. These methods are useful when trying to ascertain which features are most prominent in a place. However, in order to have an idea of which region in Africa people feel they 'belong' to, or how people relate to other people on the continent, a more intricate method is necessary. The methods used here are based on relational data and, as such, follow in the 'new regional geography' tradition. This tradition will be explained in more detail below.

The old way of regionalizing is further criticized for shaping the minds of students (Johnston 1991), giving them a jigsaw-puzzle view of the world (Lewis and Wigen 1997, 10). In addition, national borders have been the preferred lines over which to trace the regional delineations, which, in Africa's case, is an unfortunate remnant of the colonial age. Cole (2008), in an analysis of forty-two undergraduate geography of Africa textbooks, notes that both attribute data and using national borders have been and continue to be a persistent and pervasive problem. He concludes that "[t]he evidence suggests that the complex physical, environmental, and cultural geographies of Africa make regionalization of the continent based on putatively objective criteria seem inadequate, idiosyncratic, sometimes anachronistic, and perhaps impossible, particularly when the country is used as the grouping unit" (Cole 2008, 70).

Regionalization is also important in the subject of political economy. Regional economic communities (RECs) are groupings of countries who, through cooperation, seek to gain an advantage in an ever-globalizing world. The way in which RECs have come into existence in Africa has been criticized by adherents of the New Regionalism Approach. Söderbaum and Taylor (2008) claim that rather than constructing economic regions with the expectation that they will result in improved regional cooperation, one must examine the way in which regions are being formed through social interaction.

Separate from, but related to regional geography, urban geographers have also shifted their focus from attribute data about cities to network data about the relationships between cities. Developments made in world city network studies have shown that it is useful to view the world as an interconnected web, where the magnitude and direction of the flows are strong indicators of

the spatial structure of the web. The world city network is relevant here because it allows for the demarcation of regions by using relational data and ignoring state boundaries.

This article is structured as follows. It will begin with a review of the study of regionalization in general, followed by a review of past regionalizations of Africa. Subsequently, world city network research will be reviewed and the methods and data will be introduced. The results will be presented and will be compared and contrasted with current methods of regionalization in education and in regional economic cooperation. Finally, a sub-regional map of Africa, based on the results, will be shown, followed by a conclusion.

2. REGIONALIZATION

The concept of regions is one of the most basic concepts in geography (Paasi 1986). As such, the process of regionalization has had an important place in the history of the discipline and has undergone changes in its definition, in its perceived value and in its methods. A region can simply be defined as “a subdivision of something larger, more extensive” (Smith 1996, 189). The practice of regionalization is hence “a process of dividing the earth or an area of the earth’s surface into smaller, more homogeneous, units or grouping like units into larger units for close analysis” (Cole 2008, 62).

Regionalization has usually been an element of regional geography. John Fraser Hart calls regional geography the production of ‘evocative descriptions that facilitate an understanding and an appreciation of places, areas and regions’ (Hart 1982, 2). Thus, regions are delineated in order that they may be studied and taught. Paasi (1986, 106) remarks that “[r]egional geography is still one of the fundamental approaches in schools, an aspect which is crucial for the constitution of our outlook on world as part of social reproduction.” The difficulties faced when defining regions have been acknowledged by most geographers (Hartshorne 1959; Cole 2008). The boundaries of regions are almost always difficult to define.

In the first half of the twentieth century, regionalization relied heavily on facts (Johnston 1991). Grigg (1967) identifies three early paradigms of regionalization. The first is the “pays” approach which purported that “unique regions of people and place could be identified that were rooted in long-term interactions between people and the environment and that the delineation of discrete units was possible” (Cole 2008, 61). The second tradition is natural regions. With this approach an attempt was made to find boundary areas based on the physical features of the

environment such as landforms, climate and soil and vegetation (Cole 2008). The third tradition is the single feature region which identifies regions based on one feature which could be physical like the features of natural regions or human such as language or religion (Cole 2008). These traditions were different approaches to classification. In that period it was the task of geographers such as Hartshorne (1959) to “synthesize spatial sections of the earth’s surface” (quoted in Johnston 1991, 39; see also Paasi 1986). These traditions were criticized in the 1960s as being merely boring collections of facts unable to excite potential readers and researchers (Johnston 1991, 40).

Beginning in the 1970s, a new method of regionalization was developed by geographers. Pred (1984) noted that regions should be based on real processes that are occurring on the ground. He based his arguments on sociology’s structuration theory which was developed by Anthony Giddens. According to Giddens (1984), social structure is a continually changing structure that is being shaped by the people within it, who in turn are themselves influenced by the structure they have created. Regions are therefore not concrete but are dynamic, continually being shaped by the people who are making decisions within them. Regions, in this sense, are an ‘interaction structure’. This new paradigm for regionalization is known as ‘the new regional geography.’

The approach to studying regionalization has undergone similar changes outside the discipline of geography, particularly in political economy. Adherents of the New Regionalism Approach are critical of RECs. Söderbaum and Taylor (2008, 20) describe them as “inter-state or policy-driven frameworks” which “tend to take [regions] as pre-given, defined in advance of research, with a strong emphasis on ‘territory’ and ‘rule.’” Regionalism should instead be understood as a “process through which regions come into existence and are consolidated – their “becoming” so to speak – rather than a particular set of activities and flows within a pre-given, and often pre-scientific, regional space or regional framework.” According to Hettne and Söderbaum (2000, 457-459), “‘Regionalisation’ denotes the (empirical) process that leads to patterns of cooperation, integration, complementarity, and convergence within a particular cross-national geographical space.” They emphasize the fact that regions cross national boundaries and that “social processes must be analysed delinked from national space.”

3. REGIONALIZATION OF AFRICA

Africa has not been left out in the process of regionalization. Africa has been divided up according to features, both natural and human, whether it be climate, soil, language, colonial history or any one or a combination of the many features that are available for study. A major problem with using features is that the features almost always cross national borders. Usually, for the sake of simplicity, a region is made up of a number of nation-states with similar features, thereby having as its boundary the boundaries of the countries it is made up of, regardless of the boundary of the feature. This issue is perhaps more common in Africa than in other areas of the world since the national borders which were put in place by colonial powers held little regard for the language, culture and ethnicity of the native population.

Since there are so many ways to regionalize Africa, it goes without saying that there are countless sub-regions depending on the context and the author's preference. Roy Cole (2008), in an excellent comprehensive review of regions in undergraduate geography textbooks over a fifty-one year period, demonstrates just how diverse it can be. Cole reviews forty-two textbooks with a goal of analyzing which regions were identified by authors and what criteria each author used to distinguish between regions. He shows that the number of regions in those textbooks ranged from four to twelve with an average of 7.3. In the earlier texts, physical geography was the most common criteria. In later years, the criteria evolved from physical and political to relative location. In addition, relative location descriptions, such as western, southern, etc. are the most common way to name regions. Overall, sixty-one unique names were used (Cole 2008). Cole notes that some authors went to great lengths to justify their decisions while for some it was arbitrary. There is little agreement between authors. The countries most commonly disagreed upon are those which straddle the boundary of two regions such as Chad, Cameroon, Rwanda and Burundi.

Cole (2008) demonstrates that often regions remain unchanged when a change is due. For example, the Central African Federation, which existed between 1953 and 1963 and included Northern Rhodesia, Southern Rhodesia and Nyasaland, was used as the principal variable of identity for a region named Southern Central Africa in a 1974 textbook, eleven years after the end of that federation. This confirms an issue raised by Lewis and Wigen (1997), who state that regions tend to imply an essentially stable world order. Cole (2008, 69) words it as follows, "once they have been identified regions may acquire a life of their own, a taken-for-granted

reality that on inspection is not warranted.” In 1995, a textbook by Newman (1995, in Cole 2008) employed the new regional geography concept by focusing on socio-cultural changes over time and space. This textbook is unique in Cole’s (2008) analysis in that it ignores state boundaries and has overlapping regions. Though this textbook was unique, it was one of the later ones and may therefore indicate a potential shift in future geography textbooks towards an approach which disregards the traditional method of grouping nation-states.

Within a political economy framework, regionalization in Africa is manifested through the numerous RECs. Africa currently has eight RECs that are recognized by the African Union (2003). The World Bank (2009) recognizes an additional five African regional institutions and economic integration arrangements. Regionalization is one of the goals put forth by The New Partnership for Africa’s Development (NEPAD). This program, which was created in 2001, is a pledge by African leaders to work together to eradicate poverty and create sustainable growth through economic partnership (NEPAD 2001, 1-23). The program lists economies of scale to be one of the problems for the smaller countries. The NEPAD program demonstrates that Africa’s leaders acknowledge that there is a link between globalization, regionalization and economic prosperity.

Many economists and policy makers agree with the benefits of regional cooperation. Section 2 showed, however, that adherents to the New Regionalism Approach claim that the way in which these regions are formed is incorrect. Studies following this approach have focused especially on Africa. According to Söderbaum and Taylor (2008, 21), regional projects such as ECOWAS and COMESA have a poor track record which leads to a lack of confidence in these regional projects. Rather than taking a state-centric approach, Söderbaum and Taylor (2008, 15) “favour an approach that looks at African regions as they actually are and how they are really being constructed”. According to them, “any serious analysis of micro-regions in Africa needs to scrutinise and try and make sense of the ways in which Africans encounter (and shape) regional dynamics and how various forces, be they based on ethnicity, gender, identity or occupation, influence Africa’s encounter with regionalism.”

In summary, sections 2 and 3 have shown that the process of regionalization has changed and come to be understood as an analysis of interaction within space rather than a listing of facts about space. In addition, the traditional ideas about states, regions and continents have been criticized for being rigid and overvalued. Regionalization is beneficial when real interaction

processes are used. The methods employed here will involve such real interaction processes by analyzing the movement of people across Africa. The following section will explain how the world city network in general and airline connections in particular can be used to measure the interaction space and determine the spatial dimensions of regions.

4. REGIONALIZATION BY ANALYZING THE URBAN NETWORK

The World City Network (WCN) makes it possible to base regionalizations on the interaction structure of a region without using national borders. Inter-urban networks as a research agenda was brought into the fold by John Friedmann's (1986) World City Hypothesis. Friedmann claims that world cities are centers that control and articulate the New International Division of Labor. More specifically, "[k]ey cities throughout the world are used by global capital as 'basing points' in the spatial organization and articulation of production and markets. The resulting linkages make it possible to arrange world cities into a complex spatial hierarchy" (Friedmann 1986, 71). Transnational urban networks are therefore an alternative means of looking at the spatial organization of the globe and have useful implications for regionalization studies.

The idea of a transnational urban network was further theorized and developed by Saskia Sassen (1991, 1994). Sassen puts an emphasis on globalization processes which have been occurring over the past twenty years, and describes cities as control centers in the global economy (Sassen 2002, 15). In the past, the international economy was organized mainly through the inter-state system. According to Sassen (2002, 13), "it is this condition that has changed dramatically over the last decade as a result of privatization, deregulation, the opening up of national economies to foreign firms and the growing participation of national economic actors in global markets." As the national, as a spatial unit, is being weakened, there is room for other spatial units and scales, including the sub-national (cities and regions), cross-border regions and supranational entities (Sassen 2002, 13).

Studies that attempt to measure the WCN use data that represent connections between cities. In the case of Africa, we are not attempting to measure the connections between world cities per se, since Africa has few, if any, cities that can be described as control centers in the global economy. However, the underlying premise of this research is that the world can be analyzed from the perspective of the city-network rather than states. According to Derudder et al.

(2003), the WCN makes it possible to measure the hierarchical and regional patterns of cities, and formal network analysis has been described as an appropriate method of conceptualizing the world city network (Smith and Timberlake 1995; Derudder et al. 2003).

As urban researchers have taken on a network approach, it has prompted the need for relational data rather than attribute data. The advantage of using airline data for this approach is obvious. These data are easy to obtain, air transport is traditionally organized through cities rather than states and transport is mainly about connections and flows (Derudder and Witlox 2005). In addition, airports are hierarchically constructed (Grubestic et al. 2008, 53). The actual datasets and the methods of computing them vary. Studies include Smith and Timberlake (2001), Derudder and Witlox (2008), and Derudder, Devriendt and Witlox (2007). See Derudder and Witlox (2005) for an overview of past studies that have used airline data.

It is useful to include here a brief description of the airline industry in Africa during the last fifty years. After African states gained independence, air transport was highly regulated in an effort to protect national flag carriers (UNECA 2001, 1). This resulted in a small number of strong airlines. The situation did not serve the interests of consumers, nor did it help strengthen the majority of airlines or allow for growth of the airline industry in Africa in general (1). To address these issues, forty-four African states signed onto the Yamoussoukro agreement for the liberalization of African airspace in 2002. According to the United Nations Economic Commission for Africa (UNECA) (2001, 1), liberalization is meant to “help meet the rapidly changing needs of the African market and the globalization of the economy.” In addition to the agreement for liberalization, several RECs have adopted their own sub-regional arrangements which go beyond the 2002 treaty (UNECA 2001, 3; Marawa 2003). Therefore, as well as the benefits of using airline data which were listed in the previous paragraph, airline data is also appropriate because of the link between air transportation and economic regionalization.

The methods used here are based on Grubestic et al. (2008), who use network analysis to construct nodal regions based on airline data. For the construction of nodal regions, a method which was developed by Nystuen and Dacey (1961) is used. It is referred to as Nystuen-Dacey (N-D) nodal analysis. Nystuen and Dacey (1961) base their method on the idea that “the direction and magnitude of flows associated with social processes are indicators of spatial order in the regional structure of urban society” (29). Other research which has used similar approaches to regionalization includes Reed (1970), Newman (2006) and a recent study on the

regional boundaries of Great Britain based on a network of human interactions (Ratti et al. 2010).

Nodal regions are delineated by aggregating a number of area units which have a city as a central place for each unit. For the purpose of this research, the area unit is the service area of the city's airport. The area units are aggregated according to the connections between the cities (Nystuen and Dacey 1961). The key feature of N-D nodal analysis is that for each node, only the strongest upward connection is considered. This does not mean that other connections do not exist or are not important. However, in order to define a nodal structure, the "dominant association" is the critical concept (Nystuen and Dacey 1961, 31). For example, Cape Town has connections to several cities in Africa, including Johannesburg, Durban, Port Elizabeth and several others. Since Cape Town's strongest connection (as measured in passengers per week) is with Johannesburg, Cape Town is considered to be part of Johannesburg's nodal region, regardless of the other connections.

This method results in each nodal hierarchy having one dominant or independent city. This is the city whose largest flow is to a city with a smaller total flow. This measure of size must be assigned. In this case, the total flow of the city to all other cities in Africa is used. For example, there were 47 175 passengers per week (PPW) who flew between Johannesburg and Cape Town. This is the strongest connection for both of these cities. Since Johannesburg had 143 494 PPW for continental flights and Cape Town had 64 759 PPW for continental flights, Johannesburg is considered the dominant node (in other words it has a larger airport). A subdominant node is one whose largest flow is to a city with a larger total flow, so Cape Town is subdominant to Johannesburg. A subdominant node may in turn be dominant in relation to other cities whose largest flows are to that subdominant node. The dominant or independent node is called the tier 1 node or terminal point. It has no cities above it in the hierarchy. Cities connected to it are called tier 2 nodes. Cities below that are tier 3 nodes. Further subdominant nodes are designated as tier $m + 1$ nodes, where m is the tier of the city it is subdominant to (Grubestic et al. 2008).

This method is useful because it takes only the most important upward connection for each city. This means each city is connected to only one city of a higher level, allowing it to be isolated into one region, i.e. the region of the city it is connected to. This method also allows for the ability to further divide each region into sub-regions. Especially useful is that this method

completely eliminates zero values which tend to be a problem in other types of network analysis, especially when there is a large dataset as is the case here.

As mentioned, each city is the central place of an area unit. Nodal regions are delineated by aggregating a number of area units. The area unit whose city is subordinate to another city will be a part of the same region as the area unit of that dominant city. A method must be employed in order to decide on the geographic extent of the area unit beyond its central city. This was achieved by employing a voronoi tessellation. The area unit of any given city is the area where that city is the nearest city. Essentially this is achieved by drawing a line at equal distances between cities. This method is appropriate because people living in an area beyond a city are likely to go to the nearest airport when wanting to fly somewhere. For example, someone who lives closer to Port Elizabeth than to East London is more likely to make use of Port Elizabeth's airport, making that location part of the area unit of Port Elizabeth. By using this method, a map with regions and sub-regions with complete coverage of Africa is possible.

The data used for this study came from the Marketing Information Data Transfer (MIDT) database. This database contains information about airline bookings. This paper makes use of the MIDT-database for the period of January through August 2001. Information regarding bookings by travel agents who use Global Distribution Systems (GDS), such as Galileo, Worldspan, etc., is included in the MIDT. Bookings occurring directly at an airline are not included. The MIDT dataset is advantageous because it includes global flows rather than international flows, and it includes real bookings as opposed to schedule data as a proxy for real passengers (Derudder and Witlox 2005).

In order to extract the data for this particular study, a number of steps were taken. It was decided to use each individual flight segment rather than only the origin and destination. One of the critiques of past World City research using airline data is that most data considers each segment as a discrete trip and thereby masks true origin-destination relationships, since airlines make use of a hub-and-spoke network as part of their corporate strategy (Derudder and Witlox 2005). However, Grubestic et al. (2008, 55) point out that "from a geographic standpoint, hub-and-spoke network structures are indicative of key relationships between airports and their associated hinterlands. Therefore, even though true origin-destination flows can be masked by hubs in many instances, the simple fact that passengers must connect via hub-and-spoke systems is geographically relevant." In addition, "the presence of a hub airport in a major metropolitan

area is probably indicative of that city's central place in the national and international system of cities" (Smith and Timberlake 2001, 1670). Of interest for this study is knowing which destinations are available for a passenger to fly to directly from any given city.

The next step was to isolate the flight segments with origin and destination in Africa. In order to make the data more workable and the figures easier to interpret, the number of flight segments was multiplied by a factor of 7/243 to reflect passengers per week. In a following step, all segments with less than five PPW were removed from the table, in order to reflect important connections between cities. The resulting data matrix included 255 cities, 1130 city-pairs and 9 651 410 passenger flight segments. In a final step, the in- and outflow of cities were added together to create total flow.

5. RESULTS

The results section will begin with a general description and explanation of the results. The continent will be addressed as a whole here. The nodal hierarchies will be briefly described, including which cities are involved and the geographic extent of the connections. Subsequently, three of the nodal regions, Johannesburg, Nairobi and Douala/Libreville will be described in more detail. These three regions will be compared with the twenty-eight sub-regional maps included in Cole's (2008) analysis and with some of the existing RECs.

[Figures 1 and 2 somewhere here]

Figures 1 and 2 show the results of the N-D nodal analysis displayed on a map. In Figure 1 the line thickness denotes the number of passengers. Overall, the results are not surprising. Most of Africa's largest cities are tier 1 cities, although some large cities, such as Lagos, are tier 2 cities. Tier 1 cities are geographically dispersed but tend to be located on or near the coastline. In fact, the two tier 1 cities furthest inland are Nairobi, at about 400 km from the coast, and Johannesburg, at about 450 km from the coast.

It appears from this map that national borders affect where people fly. Several tier 1 and tier 2 cities serve as a node for all other cities in the country in which they are located. In addition, the most popular routes (in PPW) are within countries, not between countries. Figure 2 shows the colonial possessions of each country in 1930. There are some nodal hierarchies where there appears to be a correlation between the colonial power and the connections between cities.

This is especially the case for Abidjan. This issue will be looked at more closely in section 5.1 below.

5.1 Johannesburg

Johannesburg has the most total PPW in Africa (143 494) and the strongest connection with another city (47 175, Cape Town). It is connected to more cities than other tier 1 cities (35) and has the largest geographical scope. Johannesburg dominates, not surprisingly, the southern region of Africa including the countries of South Africa, Lesotho, Swaziland, Namibia, Botswana, Zimbabwe, Mozambique, Angola, Zambia and Malawi. Johannesburg's region appears to be consistent with current national borders. There is only one country, the Democratic Republic of the Congo (DRC), that is part of both Johannesburg's region and another region. In the DRC, Lubumbashi is a tier 3 city under Harare, while Kinshasa is a tier 2 city under Nairobi. Other than this exception and the western African cities of Lagos and Accra, Johannesburg's region's northern extent essentially follows the northern borders of Angola, Zambia, Malawi and Mozambique.

That the cities of Lagos and Accra have Johannesburg as their strongest connection is perhaps the most noticeable part of the Johannesburg nodal hierarchy. These two cities are twice as far away from Johannesburg as Luanda, the next furthest city. Additionally, they do not form part of a geographically contiguous area either with each other or with the rest of Johannesburg's region. No existing regionalization maps put these areas in the same region as southern Africa. One likely explanation for why Nigeria, Ghana and Sierra Leone are part of Johannesburg's region is that they were British colonies while most of the bordering countries were French colonies (see Figure 2). Liberia was not a British colony, but due to its history, it would have a better connection with Anglophone countries.

There are some historical legacies that have been left by colonialism, which appear to continue to have an effect on the interaction structure of this area. One significant legacy, especially as far as air transportation is concerned, was the creation in 1961 of Air Afrique. This airline was started in 1961 by an agreement between eleven former French colonies. Air Afrique was owned by these eleven countries as well as Air France and UTA (Smith 1962). Air Afrique went bankrupt in 2001 (Blunt 2001). According to the Atlas on Regional Integration in West Africa, the existence of Air Afrique limited Lagos' connections with the rest of the region (ECOWAS-SWAC/OECD 2006). The situation has changed somewhat since the bankruptcy of

Air Afrique and the liberalization of African air space in 2002. One of the major regional strategies for Nigerian Eagle Airways (formerly Virgin Nigeria) is to have more connections with French-speaking countries in the region. With the introduction of flights between Lagos and Abidjan in 2008, Nigerian Eagle Airways' C.E.O. stated that "[Nigerian Eagle Airways] is strengthening her ties with the Francophone countries and the launch of flight services to Abidjan will enhance travel options available to the traveling public on the route as well as providing access between the Francophone and Anglophone countries in the West African region" (Virgin Nigeria Airways 2008). It is clear from this statement that the language-barrier has been an issue in the past. A second historical legacy of colonialism is the different currencies that are used by Anglophone and Francophone countries of this area. The former French colonies use the CFA Franc. This is also reflected in the division of the ECOWAS regional economic community between mainly French-speaking countries (UEMOA) and mainly English-speaking countries (WAMZ).

An additional issue concerns Lagos' size and importance to its surrounding hinterland. Lagos is the second largest city in Africa and is approximately twice the size of Johannesburg (Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat 2008). This raises two important questions: Why is Lagos not a tier 1 city, and why is Lagos not a more important node for the surrounding geographic area? Accra serves a more important regional function than Lagos since it has Freetown and Monrovia underneath it in its hierarchy. This issue highlights an advantage of using relational data. Attribute data, such as the size of a city, would make Lagos appear to be an important regional city. This nodal analysis shows, however, that city-size is not necessarily a straightforward indicator for regional importance, at least as far as airline connections are concerned.

As for the remaining tier 2 cities in Johannesburg's hierarchy, there is little here that is surprising. The tier 2 cities with the most tier 3 cities are Cape Town, Windhoek, Maputo and Luanda. These cities can therefore be considered important nodes in the Johannesburg hierarchy. With the exception of Cape Town, these cities are the capitals of their respective countries. Their hinterland includes most other cities in their country which indicates that national borders have an effect on passenger airline flights. Luanda is the node for all other cities in Angola, while Maputo is the node for all other cities in Mozambique. Windhoek is the node for only the

northern half of Namibia since the two cities in southern Namibia, Leuderitz and Oranjemund, are served by Walvis Bay and Cape Town.

Other capital cities have less of a stronghold compared to the above mentioned three capital cities. In Botswana, the capital city of Gaborone is a tier 2 node for only Francistown, while Maun is the tier 2 node for Kasane. In Zimbabwe, the capital city of Harare has two cities below it in the hierarchy, Bulawayo and Lubumbashi, DRC. Victoria Falls is directly connected to Johannesburg. It serves as the tier 2 node for Hwange National Park and Kariba. The fact that most of Lubumbashi's travelers fly to or from Harare is somewhat unexpected compared to the rest of the results. Most tier 3 cities are located in the same country as its dominant tier 2 city, and the DRC does not border Zimbabwe. That Victoria Falls is directly connected with Johannesburg rather than Harare can be explained by the fact that it is an important tourist destination. Tourists coming from outside of Africa would be more likely to visit South Africa than Zimbabwe, therefore, flying directly to Victoria Falls from South Africa. Hwange National Park and Kariba are also important tourist destinations, making them fit well under Victoria Falls in the hierarchy.

Lusaka, the capital of Zambia, is not the node for all cities in Zambia since both Ndola and Livingstone are directly connected to Johannesburg. Livingstone is in a similar position as Victoria Falls in that its status as a tourist destination may account for its direct connection to Johannesburg. Ndola is an important commercial center in Zambia (Zambia National Tourist Board, n.d.), which may explain why there are more passengers between Ndola and Johannesburg than between Ndola and Lusaka. Lusaka does serve an important regional function, having two cities subdominant to it.

In Malawi, Lilongwe is the node for the northern region, while Blantyre is the node for the southern region. When considering that Lilongwe is the capital and Blantyre is the largest city, this cannot be deemed surprising. Both cities serve an important function and, therefore, require being directly connected to Johannesburg. These results indicate that Malawi can be divided into a north and a south region.

When comparing these results to sub-regions that have been constructed by geography textbook authors, there is no congruence. This is simply due to the fact that none of those authors put western Africa and southern Africa in the same region. However, when taking only the southern part of Africa from these results (i.e. by excluding Lagos and Accra), four of the

twenty-eight geography of Africa textbooks in Cole (2008) are congruent with the results, having as the northern border of the region the northern borders of Angola, Zambia, Malawi and Mozambique. An additional four authors had the same northern border for the region but included Madagascar. The most popular make-up for a 'southern Africa' region is Namibia, Botswana, South Africa, Lesotho and Swaziland, in eight textbooks (Cole 2008). The results of this nodal analysis show a southern Africa region which is larger than conventionally accepted.

5.2 Nairobi

The geographic area of Nairobi's hierarchy covers most of eastern central Africa including the countries of Kenya, Tanzania, Ethiopia, Eritrea, Djibouti, Somalia, Uganda, Rwanda and Burundi. It appears to follow more of a pattern than the other nodal hierarchies. It follows national borders. Cities in Kenya, Uganda, Rwanda, Burundi and Eritrea are connected to only Nairobi. Cities in Ethiopia, Djibouti and Somalia are connected to only Addis Ababa. Cities in Tanzania are connected to only Dar es Salaam. One exception to this is the island of Zanzibar which bypasses its capital Dar es Salaam in the hierarchy and has Nairobi as its strongest connection. The other exception is the DRC. Kinshasa is part of Nairobi's nodal hierarchy while Lubumbashi is part of Johannesburg's nodal hierarchy.

Nairobi is centrally located in the region in between the two tier 2 cities that are also important nodes, Addis Ababa and Dar es Salaam. Tier 2 cities are spread out evenly around Nairobi. Tier 3 cities are spread out around Addis Ababa and Dar es Salaam. Dar es Salaam is, however, poorly connected to the southwestern part of Tanzania.

Of the twenty-eight geography textbooks in Cole (2008), none of them had a region that was congruent with the Nairobi nodal hierarchy. However, this can be explained by the fact that none of the authors put the DRC in an 'eastern Africa' region. When Kinshasa is taken out of the picture, two of the twenty-eight geography textbooks agreed with these results. In both cases the region was named Eastern Africa. Most other texts put Ethiopia, Somalia, Djibouti and Eritrea in a different region often referred to as Horn or North-East Africa. Nineteen textbooks have a region called East or Eastern Africa which contains Kenya, Tanzania, Uganda, Rwanda and Burundi. Hence there appears to be a general consensus that the southern half of Nairobi's nodal hierarchy is one region and the northern half another. The results of the nodal analysis indicate that it may, perhaps, be more appropriate to view this area as one region.

Lookin at RECs, all the countries in Nairobi's hierarchy are members of either the East African Community (EAC) or the Intergovernmental Authority on Development (IGAD). The EAC includes all the countries except Ethiopia, Somalia, Eritrea and Djibouti. The IGAD includes all the countries except Tanzania, Rwanda and Burundi. The IGAD also includes Sudan which has no cities that are a part of Nairobi's hierarchy.

Plans are being made to federalize the EAC member countries – Kenya, Tanzania, Uganda, Rwanda and Burundi – into a single state called the East African Federation (The Economist 2009). The results of the nodal analysis indicate that there is indeed a strong connection between these five countries. However, the question of how this would affect the more northern countries arises. It appears from these results that combining the EAC and the IGAD into one regional economic bloc would make it stronger. There are strong connections between cities of these two RECs. According to the article “An East African Federation: Big ambitions, big question-marks” which appeared in The Economist on September 3, 2009, expansion beyond the existing EAC countries may be a feasible option in the future. In fact, the article proposes that if the region is defined by the lingua franca of Swahili, the range of trucks leaving the port of Mombasa and Nairobi's status as a hub, it would include an area extending from Ethiopia and Somalia down to northern Mozambique. Hence, the Economist article supports the idea of using the interaction structure which is based on existing connections and flows as a basis for regionalization.

5.3 Douala/Libreville

The N-D nodal analysis shows that Douala and Libreville are both tier 1 cities. These two cities are unique, however, for several reasons. They are located closer together than any other pair of tier 1 cities (see Figure 2). They are located in neighboring countries, while no other pair of tier 1 cities is. Finally, there is a strong connection between these two cities. After looking at each nodal hierarchy and comparing them with regionalizations in school textbooks, the case will be made here that there is strong evidence for a single bipolar region, with some cities oriented toward Douala and some cities oriented toward Libreville.

The Douala nodal hierarchy, even though Douala is one of the smaller tier 1 cities, covers a relatively large area, including cities in five countries (Cameroon, Chad, Central African Republic, Republic of the Congo and Equatorial Guinea). Five of the nine cities in the hierarchy are in Cameroon. The four remaining cities are each in a different country.

In the twenty-eight geography textbooks in Cole (2008), the countries in this nodal hierarchy are usually considered to be a part of Equatorial Africa or West Central Africa. There is no region that is made up of these five countries alone. Sixteen of the twenty-eight regions have the five countries in the same region. In each of these sixteen regions Gabon is also included, and in thirteen regions the DRC is included. The general consensus among geography scholars is that Cameroon and Gabon are in the same region.

Libreville is Gabon's capital and largest city. All other cities in this hierarchy, except for Pointe-Noire and São Tomé, are located in Gabon. This hierarchy is the smallest by geographic territory of all hierarchies on the mainland. Cole's (2008) analysis shows that of the twenty-eight geography textbooks, all twenty-eight of them have Gabon and the Republic of the Congo as part of the same region, each time with several other countries as well. In twenty-four of these textbooks Cameroon is also in the same region.

Several observations support combining the Douala and Libreville nodal regions into one region. First, the two cities are located closer together than any other pair of tier 1 cities. (Al Hoceima and Casablanca are closer together, but Al Hoceima is clearly an exceptional tier 1 city). Second, they are the only pair of tier 1 cities located in neighboring countries. Third, they have a similar amount of total PPW. The total amount of intra-Africa PPW is 3561 for Douala and 2727 for Libreville. Finally, a look at the number of PPW between the two cities will show that they are also well-connected with each other. Libreville's two most important connections are Pointe-Noire (562 PPW) and Port-Gentil (545 PPW). This is followed closely by Douala with 420 PPW. Douala's most important connections are Yaoundé (576 PPW) and Abidjan (428 PPW). Douala's third most important connection is Libreville with 420 PPW. There is no other pair of tier 1 cities where the connection between the two cities is so strong (as compared to the cities' strongest connections). These observations show that Douala and Libreville are probably evenly matched as far as the influence they have in the region. The case can therefore be made that Douala and Libreville each form connected nodes in a bipolar region. This bipolar region is depicted in Figure 3.

5.5 A sub-regional map of Africa

Using the methods described above, a map was created showing Africa's sub-regions as based on the nodal regions from the N-D nodal analysis. The resulting map has some similarities to traditional regional maps but also some striking differences. There are even some similarities

to a political map showing the countries of Africa. Those nodal hierarchies which were shown to be confined within one country appear in some cases on the sub-regional map as having the approximate shape of that country. These include Casablanca (Morocco and Western Sahara) and Nouakchott (Mauritania). Some tier 2 sub-regions also appear to cover the same area as a country. In some cases, such as the Maputo and Luanda sub-regions, the sub-region appears to be an exact copy of the nation-state (Mozambique and Angola) in which it is located. The main differences include that some western African countries are found to be in a region with Johannesburg, that northern Nigeria is in a region with Cairo, and that most of the DRC is in a region with Nairobi. Of further interest is the fact that the area of the resulting map which covers western Africa looks strikingly similar to a map featuring ECOWAS' subdivisions, French-speaking UEMOA and English-speaking WAMZ.

[Figure 3 somewhere here]

This map shows that it is possible, using empirical data, to create a meaningful regional map of Africa based on the network analysis of its cities' connections. This method makes it possible to completely ignore state boundaries and to display smaller regions nested within larger ones, showing meaningful structure which in traditional regionalizations may go unnoticed.

6. CONCLUSION

The regionalization of Africa, as it was done here, is a result of the theoretical advances that have taken place and are continuing to take place. Regionalization started out simply as collecting facts about places and putting places that looked similar based on these facts in a region. In the 1970s and 1980s, the ineffectiveness of this method was laid bare after sociology's structuration theory suggested that social structure is continually being shaped by the members of the structure. Current regionalizations have also been criticized for making use of national borders (Cole 2008), for remaining unchanged (Cole 2008) and for shaping geography students' outlook on the world (Paasi 1986; Johnston 1991; Lewis and Wigen 1997). Economic regions are criticized by New Regionalism proponents for not taking into account the real connections that occur among the inhabitants (Söderbaum and Taylor 2008).

By looking at the hierarchical urban network based on the interaction structure of Africa's airline passengers, these limitations have been addressed. By using real passenger data, rather than looking at features, this method follows structuration theory by allowing for the actors on the ground to shape the region. By using cities rather than countries, it is possible to avoid using the nation-state as a grouping unit. The nature of the data also makes it possible to modify the regions over time as the situation changes.

The results show both similarities to and differences from conventionally accepted regions. Most of the regions are contiguous. In addition, national borders appear to matter. Whether or not this is a result of an imposed condition, it is obvious from these results that the majority of people tend to travel within their own country or that people must first travel to a higher order city within their country in order to fly on to a foreign destination. The most notable differences are that Lagos and Accra appear in Johannesburg's region, northern Nigeria appears in a region with Cairo, and Kinshasa is a part of Nairobi's region.

Johannesburg, Cairo, Nairobi and Casablanca appear as important nodes for airline transportation in Africa. We may want to ask how well-connected they are to the rest of the world city network. Do they act as gateways for Africa, or are other African cities equally well-connected to the world city network? If the former is the case, do these cities serve a similar gateway function in a wider economic context? Does this have economic development implications for Africa? Further world city network research may find answers to these questions (Otiso et al. 2011).

Some of the problems that were encountered during this study should be addressed. One issue was the lack of cities represented in certain geographic areas. The DRC, for instance, has only two cities that were included in this study, while Addis Ababa, for example, has connections with locales that are in fact only villages. There is no reason why villages in Ethiopia are included while villages of the same size in other countries are not. This problem may stem from an incomplete MIDT-database. Another issue is that several flights are for tourist purposes, such as the connection between Cape Town and Sun City. Though this is a real connection, one cannot conclude from this data that Sun City, which is located near Johannesburg, is a part of Cape Town's sub-region.

An additional problem concerns the manner in which area units were delineated around cities. There were some instances where the distance between two cities is so large that part of

the area between the two cities may not be part of the area unit of either city. This is especially true for the Sahara region and parts of Sudan, the Central African Republic and the DRC. Related to this is the problem that in some cases it may be possible that a large airport has a larger hinterland than a small airport. A passenger who lives 200 km from Huambo and 300 km from Luanda, may opt to travel the larger distance because the availability of flights will be larger in Luanda. In addition, national borders may still matter. A passenger may prefer an airport in his or her home country even if it is further from an airport in another country. This may be done to avoid crossing a border or simply because an airport in one's own country may be perceived to be closer. This problem could be overcome in future studies by adjusting the size of the area units according to the size or (perceived) importance of the airport. A final issue is that of the N-D nodal analysis method. Since it only takes the strongest connection into account, data on other connections (which may be almost as strong) goes unnoticed. It may be beneficial to modify the N-D nodal analysis method in a way that it takes other strong connections into account.

The methods used in this study to regionalize Africa open the door to further research. The resulting map is based on airline data and, as such, represents the interaction structure of Africa's airline passengers. The advantage of this airline dataset is that it contains cities for which there would be little to no other relational data. As more relational data become available, studies may be able to base a regionalization of Africa on other network data that represent the interaction structure of Africa's population. One of these networks for which suitable data may be available is the telecommunications network. As data regarding the economic connections between cities become more readily available, a worthwhile future study including such data, or a combination of several sources of data, may be feasible.

Acknowledgement

The authors wish to thank two anonymous reviewers who made helpful comments on a draft of this article.

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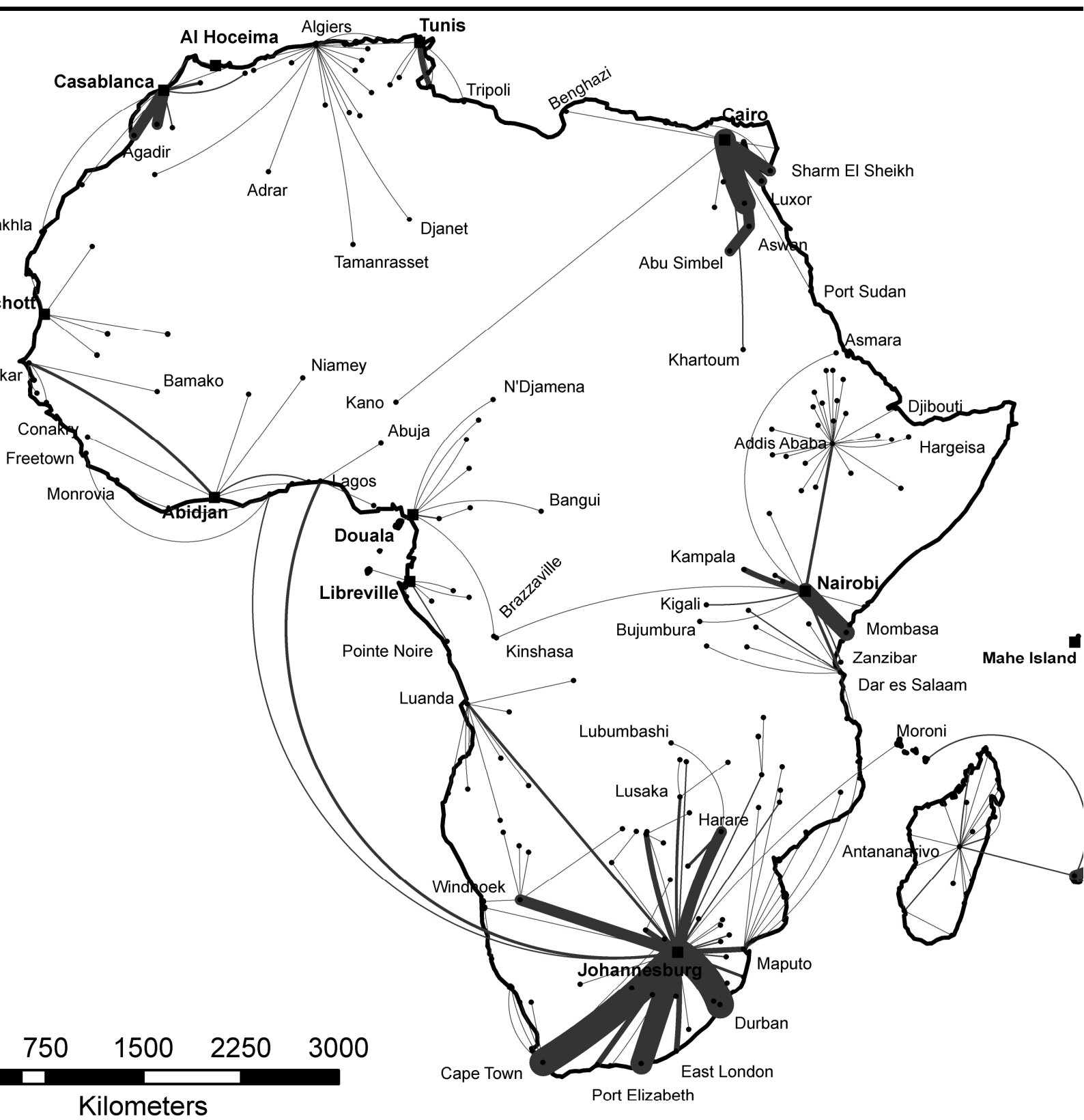
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Legend

Tier 1 City

City

Passengers per week:



10000 - 50000



8000 - 10000



6000 - 8000



4000 - 6000



2000 - 4000



1000 - 2000

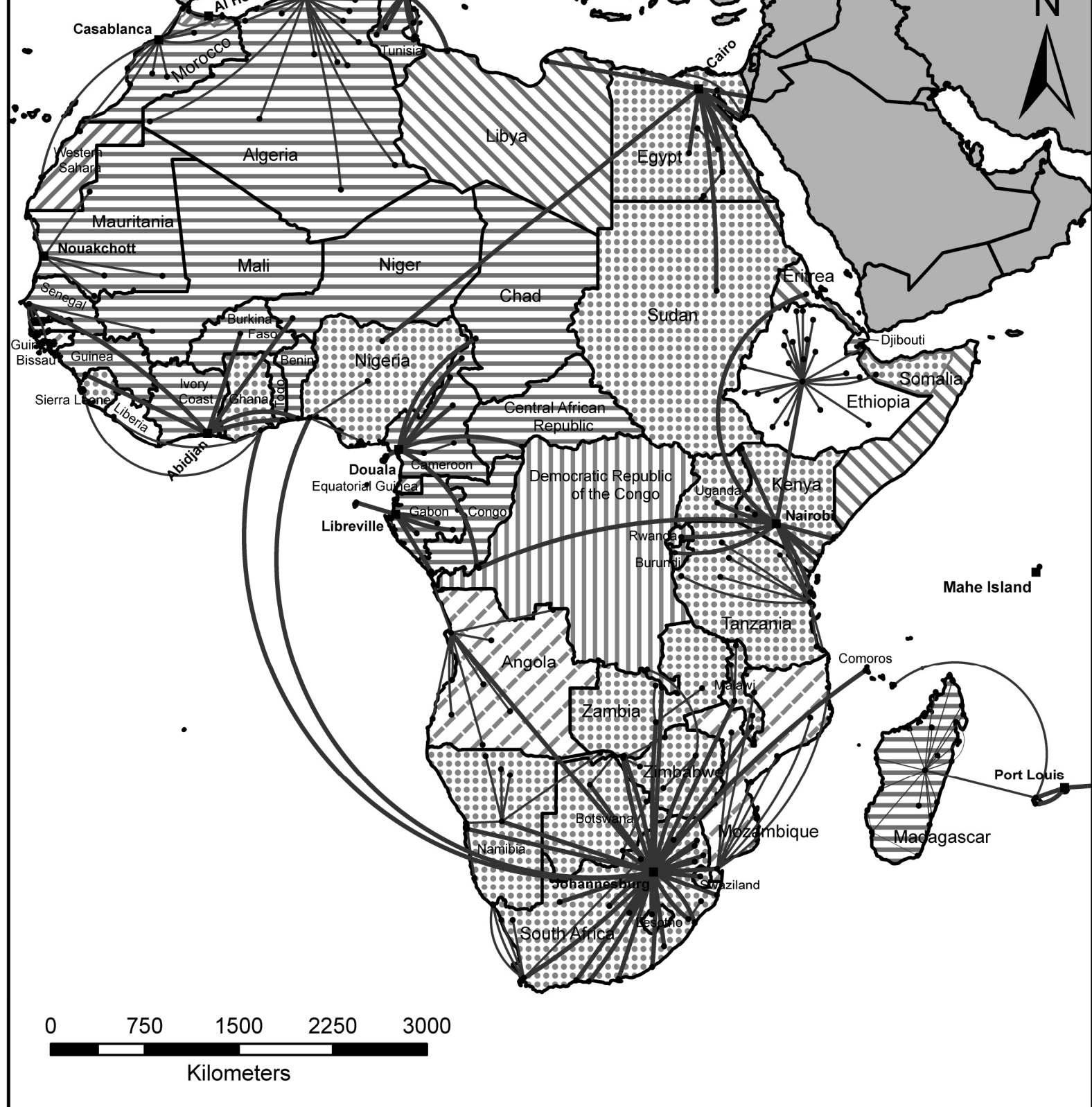


500 - 1000



500 - 1000

are taken from MIDT database representing flights flown from January through August 2001.



Level 1 connections represent the connections between tier 1 and tier 2 cities.
 Level 2 connections represent the connections between tier 2 and tier 3 cities.
 Level 3 connections represent the connections between tier 3 and tier 4 cities.
 Level 4 connections represent the connections between tier 4 and tier 5 cities.

Legend

Colonial Possessions 1930:

	British
	French
	Portuguese
	Belgian
	Spanish
	Italian
	Independent

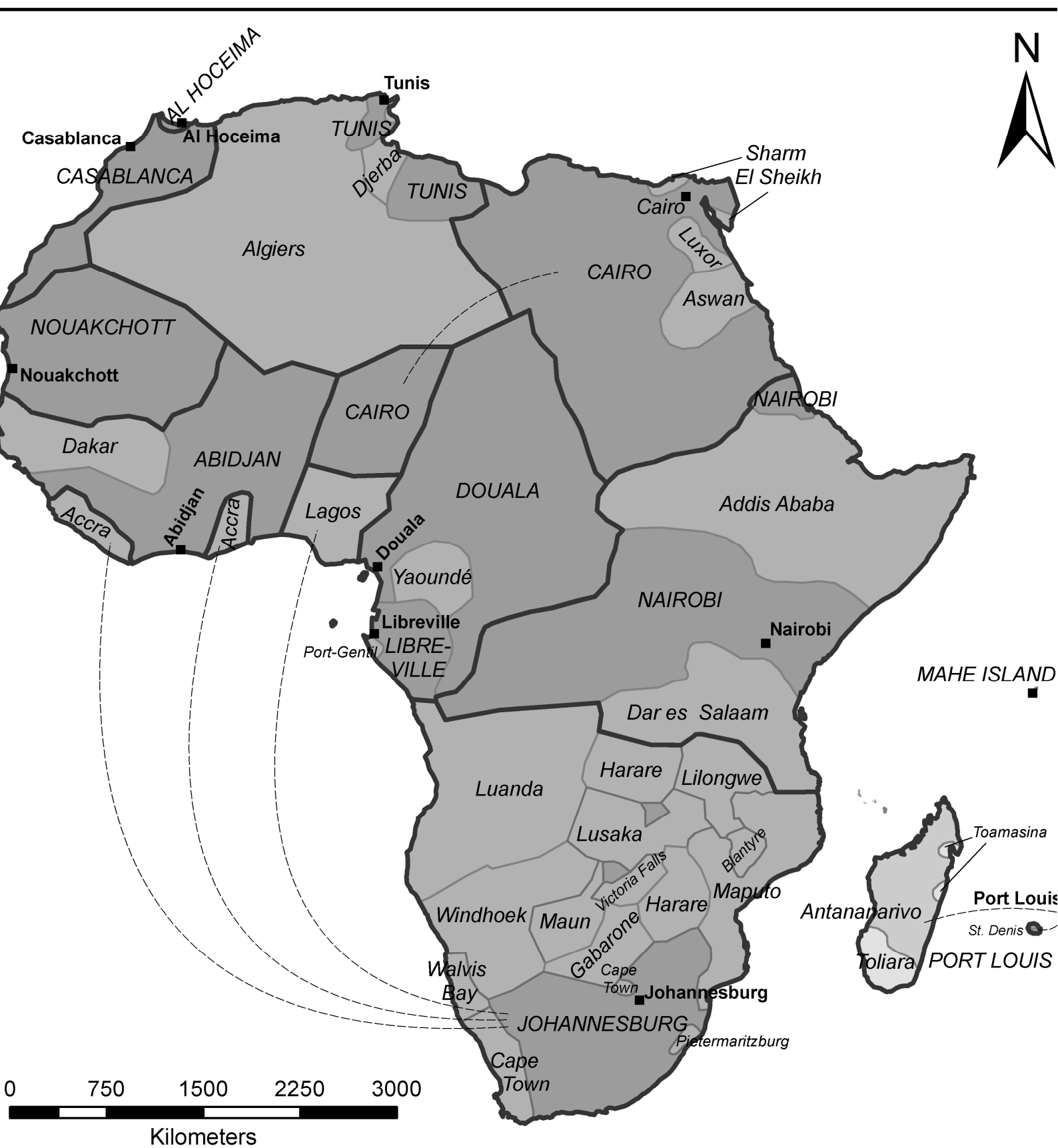
	Tier 1 City
	City

Connection Level:

	1
	2
	3
	4

Results are taken from MIDT database representing

(Source: White 1997)



Legend

■ Abidjan Tier 1 city

NAIROBI Region

Luanda Sub-region

— Tier 1 region border

Sub-regions:

- Tier 1
- Tier 2
- Tier 3
- Tier 4

----- indicates membership of non-contiguous sub-region